Design of mechanical device to transfer a seriously ill person to the operation theater

A Thesis Submitted In Partial Fulfillment
of the Requirements for the degree of

Bachelor of Technology
In
Mechanical Engineering
By

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Roll no: 111ME0328

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Rourkela-769008
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Under the Supervision Of
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CERTIFICATE

This is to certify that the work in this thesis entitled "Design of mechanical device to transfer a seriously ill person to the operation theater" by Pravas Janmejay Parida, has been carried out under my supervision in partial fulfillment of the requirements for the degree of Bachelor of Technology in Mechanical Engineering during session 2014-2015 in the Department of Mechanical Engineering, National Institute of Technology, Rourkela.

To the best of my knowledge, this work has not been submitted to any other University/Institute for the award of any degree or diploma.

Dr. Susanta Kumar Sahoo

(Supervisor)

Professor

Department of Mechanical Engineering

Acknowledgment

I avail this opportunity to extend our hearty indebtedness to our guide **Professor S. K. Sahoo**, Mechanical Engineering Department, for his valuable guidance, constant encouragement and kind help at different stages for the execution of this dissertation work. I would like to thank my classmates, other colleagues and entire college environment for their support and entrusting us with the project and finalizing this project within the limited period.

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ABSTRACT

The problem in transferring a patient from OT table to the stretcher or the transportation system is very common in almost all the hospitals or Operation theatres. Generally, the patient is transferred from the table in the operation theatre to the transporting stretcher or the like manually by hand or lifting the entire bed sheet or bed along with the patient. As we are dealing with seriously ill or injured patients, any kind of disturbances even to a small extent are likely to hurt the patient. So, a device is designed that helps in properly loading/unloading the patient on to/off the table in the operation theatre with minimal use of hands of people. The device to be designed may be semi-manual or semi-automatic or fully automatic keeping the cost that would incur in manufacturing moderate. As per procedure, initially the problem is properly defined and exhaustive search was carried out for different types of ideas or processes for the problem. After that, systematic evaluation of ideas was carried out to select the best idea or process for the product to be designed. Basically, this design is a modification of an existing design with some added features for the stated problem.

LIST OF FIGURES

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CHAPTER 1

Introduction

1.1 INTRODUCTION

The transfer of a seriously ill/injured person/patient from the cabin of the hospital or the ambulance to the operation theatre is very crucial given the fact that any slight disturbances, vibrations or the like may cause damage to the patient or affect the patient. Such patients include for example patients for heart/brain operation, heavily injured person or the like. The proposed mechanical device would be used to carry the seriously ill patient with utmost care and load/unload the same to/from the table at the OT or cabin or the table from the ambulance in a safe manner.

Basically the proposed device is a loading/unloading machine which would be equipped with the facilities that will help it being transported on the floor i.e. some wheels with the scope of being guided to any direction for travelling. The device would have to be designed in such a way that extreme care would be taken for the patient as the patient is supposed to be extremely vulnerable.

Some salient features which the device would have are:

1. Safe loading and unloading feature incorporated in the device.

2. Vibration minimization for the safety of the patient.

3. The device will be that simple such that normal people such as staffs of the hospital will be able to operate that effectively.

4. The device will have to be comfortable for the patient.

5. The device will be designed in such a way that it will be able to carry the weight of the patient without any probability of failure i.e. with a higher factor of safety.

Above all, the device to be designed will not be so much sophisticated rather it will be as simple as possible and it should be easy to handle and maintain.

CHAPTER 2

Literature Review

Methodology Adopted

Schedule of Work

2.1 LITERATURE REVIEW

2.1.1 Loading/unloading device, particularly for stretchers and the like

Fallavena F. [1] stated this in their patent back in 2010. A device for loading/unloading, particularly for stretchers and the like, from at least one supporting surface to at least one deck which is raised with respect to a supporting surface and/or vice versa, whose particularity consists in comprising means for gripping at least one stretcher which rests on a supporting surface and means for the movement, along at least two directional axes (X1, X2, X3), of the grip means which can be associated at least one frame for the movement of the stretcher between a first configuration, in which it rests on the supporting surface, and a second configuration, in which the stretcher rests on the deck for its loading and unloading.

2.1.2 A method and apparatus for patient loading and unloading

Saracen M., Carrano A. [2] designed this process. A technique and device of a situating framework are portrayed to position an upper a large portion of a body with respect to a head-end of a table. The situating framework may be a patient situating framework and may incorporate a treatment sofa, a leg rest coupled to the treatment love seat, and a drive instrument coupled to the leg rest. The patient situating framework might likewise incorporate a treatment love seat, having a base segment of a treatment sofa and majority of separable segments of the treatment lounge chair. The majority of separable bits to alter a tallness of the treatment sofa to oblige varying statures of patients.

2.1.3 Loading/Unloading unit and a transfer apparatus

Mizuno O. [3] and his team had demonstrated this process. A loading/unloading unit is shaped with a diagonal surface and an upper surface having contact territories to come into contact with a minded individual, and the angled surface and the upper surface of the stacking/emptying unit are vibrated in a heap heading and an empty course after stacking the minded individual on the stacking/emptying unit or emptying the minded individual from the stacking/emptying unit.

Hence, an exchange contraption can securely exchange the minded individual while keeping an event of the trap of the hair and so forth of the minded individual.

2.1.4 Ambulance stretcher with improved height adjustment feature

Flynn T. [4] demonstrated this process. A stretcher embodied a roller base, a scissor-sort lift edge having a lower end rotatably joined with the base, a tubular undercarriage rotatably and slidably associated with an upper end of the casing, a foldable inflexible backing positionable over the undercarriage, a delicate, foldable pad positionable over the bolster and associated thereto to forestall disassociation thusly, and first and second side-arm underpins rotatably joined with the undercarriage. The undercarriage incorporates first and second longitudinal edge individuals and first and second portable end expansions. Inward to each of the longitudinal casing individuals is a releasably bolting instrument to bolt the stretcher at a foreordained stature. The interior locking instrument is releasable permitting the stretcher to be vertically balanced by either maybe a couple thumb triggers, situated at one of the mobile end expansions.

2.1.5 Ambulance cot and hydraulic elevating mechanism therefor

Souke C. [5] had mentioned this idea in his patent. An ambulance bed is revealed and the emergency vehicle bed having a base casing designed for backing on a surface, a litter edge arranged for supporting subsequently a patient and a lifting system interconnecting the base casing and the litter casing and arranged to interconnect the litter edge and the base edge to encourage development of the base casing and the litter casing toward and far from one another. A control system is given on the bunk which is designed to encourage the development of the base casing and the litter edge toward one another and at varying paces predicated on no less than one of whether the base casing is upheld at first glance and the litter edge is bolstered by an outside bolster separate from the hoisting instrument

2.1.6 Positive lock for height adjustable ambulance cot

Lewis R. [6] was the one who had given the first glimpse of this idea. A positive lock for an emergency vehicle bunk and strategy thereof which obliges lifting an upper edge of the emergency vehicle bed, so as to allow a spring actuator to pass an impedance attack of the

positive lock, are given. On the off chance that the upper casing is not lifted, then the spring power used to draw on the positive lock is inadequate to beat the impedance fit. Passing the obstruction fit allows the bunk to be tallness balanced. Alternatively, a light marker may be given which enlightens if the bunk has not been decidedly secured a tallness balanced position.

2.2 METHODOLOGY ADOPTED

2.2.1 Need Analysis & Identification

Methods to follow:

- Observations
- Customers complains
- Users feedback
- Personal experience
- Present need of a particular group users or place, etc.

2.2.2 Need statement

The problem is to be defined clearly with its domain of solution which is desired. It generally contains:

- Problem
- Standard of performance(quality/usability level)
- Constraints (limitations)

2.2.3 Detail Fish-bone representation of problem and its factors responsible

It would explore and graphically represent the different factors responsible for the problem for which one is trying to develop a product.

2.2.4 Search for alternative ideas/Process

Methods that has been followed:

- Patents
- Journals
- Observing the nature around
- Biological process Adaptation of an existing solution
- Imitation of other solutions
- Brainstorming
-

2.2.5 Evaluation of ideas or processes

With respect to some parameters these can be evaluated. Parameters can be taken as:

- Cost
- Time to develop
- Feasibility
- Usability

The marks are to be given in a reasonable way. Different weightage can be given to different parameters. The one with the highest mark is selected for further consideration.

2.2.6 Morphological Analysis to generate alternate devices from selected idea

The ideas are to be broken to different functions/components combining which the final product can be made. For different functions there can be different alternatives possible. But out of those some may be infeasible, very costly, non-compatible etc. would be rejected. The rest of possible combinations can be evaluated further to find the device to be designed.

2.2.7 Evaluation of devices for development

Different parameters that can be selected for evaluation are,

- Cost
- Response time
- Safety
- Life period

Here also, different weightages can be given for different functions and marks can be given accordingly. The device with the highest mark will be selected for further consideration like fixing specification, simplification, standardization, drawing, modeling or fabrication etc.

2.2.8 Objective tree

It provides a checking, whether, the final product addresses all the objectives or not. It is a graphical representation of the prime and subsidiary objectives of the final product one want to develop. It will affect the decision on choosing the mechanisms and components to be used for the final product. The objective tree depends on the product.

2.2.9 SWOT Analysis

It will give an overall commercial opportunity of the developed product. It lists out Strength, Weakness, Opportunities and Threats about the product if goes for a production.

2.2.10 Detail Functional Design Tree

It will give a diagrammatical representation of each function/component requirement and their relationship among themselves. The design functional tree will be made for this product. At each level, certain critical questions are asked specific to the product like rigidity, weight to volume ratio etc.

2.2.11 Drawings and detail specification

The drafted drawings of the parts and the components are made with respective part number, dimension, tolerance, surface finish etc. Assembly drawing is also made. CATIA V5R20 solid modeling software has been used for the modeling of the product. Ergonomics, aesthetic look, safety are taken into consideration while designing the product.

2.3 SCHEDULE OF WORK

Table 1: Schedule of work

Sl. No.	Activity	Estimated Time	Activity break up (Each box = 2 weeks)
1	Need analysis & identification	4	
2	Search for alternative ideas	8	
3	Evaluation of ideas	4	
4	Alternate devices from selected idea	4	
5	Selection of best suitable device	2	
6	Objective tree, SWOT analysis, Functional design tree	4	
7	Drawings and detail specification	12	

CHAPTER 3

Need statement

Need analysis and identification

Performance standards

Fish bone representation of problem

3.1 NEED STATEMENT

To design a mechanical device that would be used to take a seriously ill/injured patient from the patient's cabin (within the hospital)/ambulance (emergency) to the operation theatre safely with utmost care. While loading/unloading the patient extreme care would be taken so as to minimize any kind of disturbances as the patient is extremely vulnerable to these.

3.2 NEED ANALYSIS & IDENTIFICATION

For the case where any slight vibration/disturbances may cause effects on the patient while transporting him/her from the cabin/ambulance to the OT or while loading/unloading the patient to/from the table at OT/cabin, there is a need of a device that would safely load/unload the patient onto/off the OT table/cabin without even touching the patient with utmost delicacy and carry the patient from the cabin of the hospital/ambulance with reduced vibration and increased comfort. Basically there is need of a safe loading/unloading technique with facilities for comfortable transportation of the patient.

3.3 PERFORMANCE STANDARDS

- The device should be cheap to manufacture.
- It must provide the patient increased comfort and reduced vibrations and disturbances.
- The maintenance cost of the device should not be high.
- The device should be easy to use for the people.
- The device should not be bulky or heavy and should not occupy large space.

3.4 FISH BONE REPRESENTATION OF PROBLEM

- It generally explores and graphically represents the different reasons responsible for the problem for which we are trying to develop the final product.
- It provides a checking, whether the final product attend to all the factors causing the problems or not.

The fish bone diagram has been shown in figure 1.

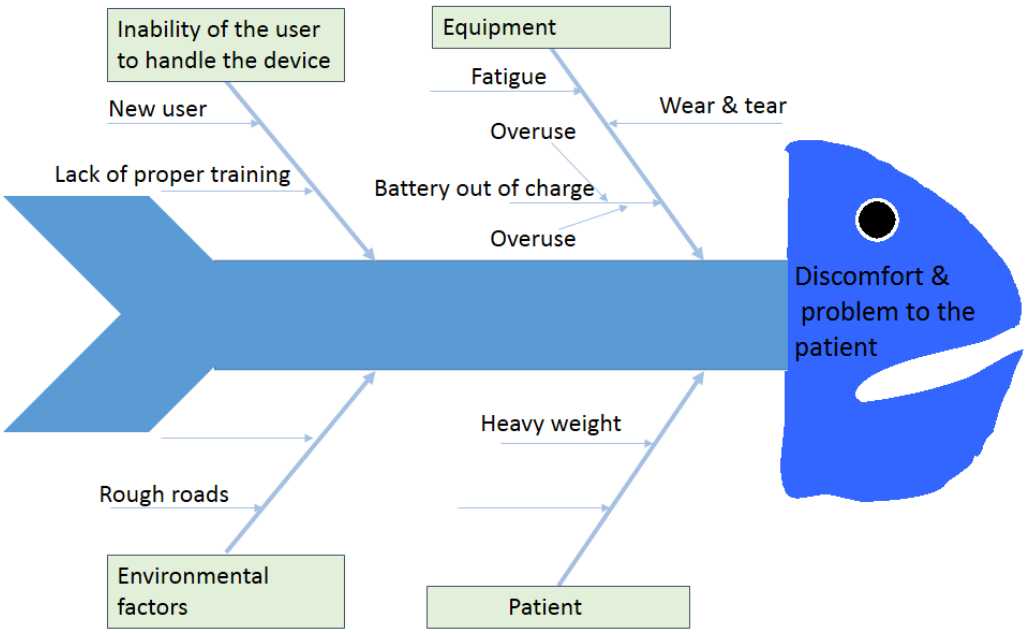


Figure 1: Fish bone representation of problem

CHAPTER 4

Alternative Ideas and Processes

4.1 SEARCH FOR ALTERNATIVE IDEAS AND PROCESSES

In this section, focus has been given to the ideas/processes that can be implemented to solve the problem. A list has been made taking all possible, impossible, feasible or infeasible, real or imaginary. Mainly the patents and journals have been looked upon for the stated purpose. The possible alternatives have been listed below along with brief explanation. Houten F. [7] and others had mentioned this procedure in a journal CIRP Annals - Manufacturing Technology.

4.1.1 Idea 1

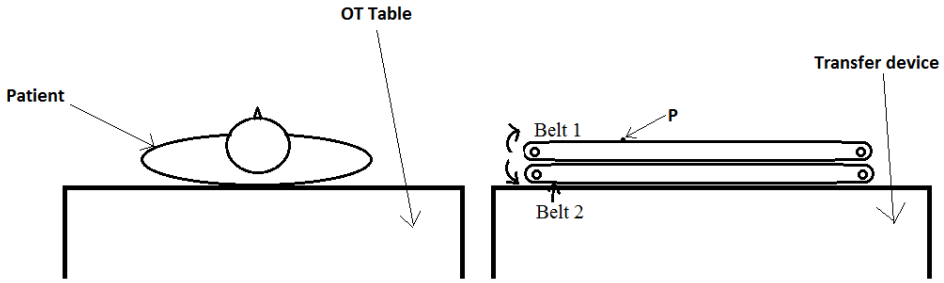


Figure 2: Idea/Process 1

As shown in the figure 2, there are two belts as indicated rotating in opposite directions. The belt 2 is used to move the device to the left. As the direction of rotation of the upper belt is opposite, as it advances due to the dynamic friction between the contact area between the belts and the back of the body is uplifted to the upper side of the belt 1. Now, the body can be taken to the other side likewise. This loading/unloading mechanism (two belt type) can be fitted to the transfer device with the transfer device being the second bed. The patient need not be touched in this case (satisfying our requirement). To raise or lower the surface of the device (to make it at

equal height of the other table) suitable kind of mechanism can be installed below the bed of the device.

4.1.2 Idea 2

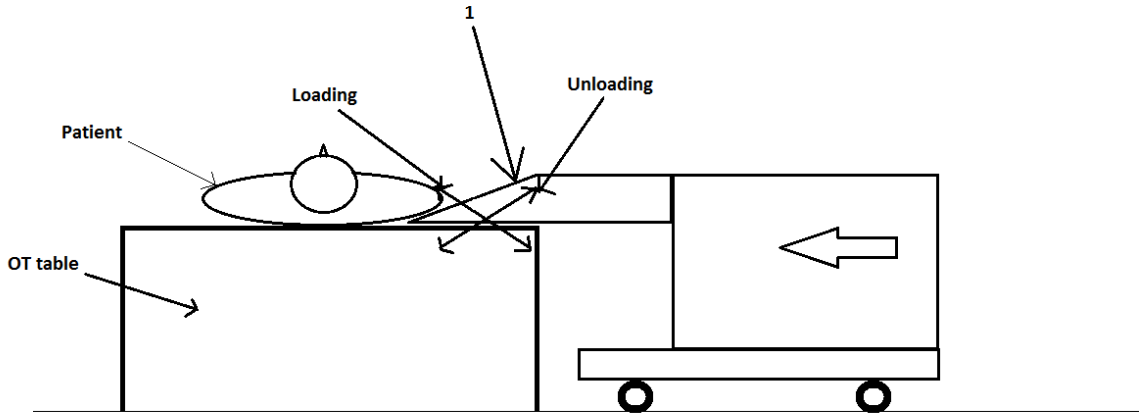


Figure 3: Idea/process 2

This idea/process is shown in the figure 3. Here the body is being loaded onto the safe mechanical device for transferring. Here, 1 is the loading/unloading element which is vibrated with small amplitude of vibration. The direction of vibration is as shown in the arrow. However, the direction of vibration can be perpendicular to the table or the other perpendicular direction. The main body of the mechanical device is moved along left with time. The principle of loading the body onto the device is friction. The static friction coefficient is more than the dynamic friction coefficient. Due to little vibrations & the movement of the end of the loading/unloading element, dynamic friction force gets acted upon the body, so with course of time the body gets loaded onto the device. As the static friction in general is more than the dynamic one, once the patient is loaded onto the bed of the device, it does not slip on it. Unloading can be done using the same principle but in an opposite way.

However, for facilitating safer & better loading/unloading of the patient, many improvements can be done onto this, like installing elastic fibers on the contact surfaces of loading/unloading element 1 to increase friction. The direction of vibration can be changed while loading & unloading to facilitate the operations being done smoothly. In this case, also the height of the bed of the mechanical device should be adjusted using a suitable mechanism.

4.1.3 Idea 3

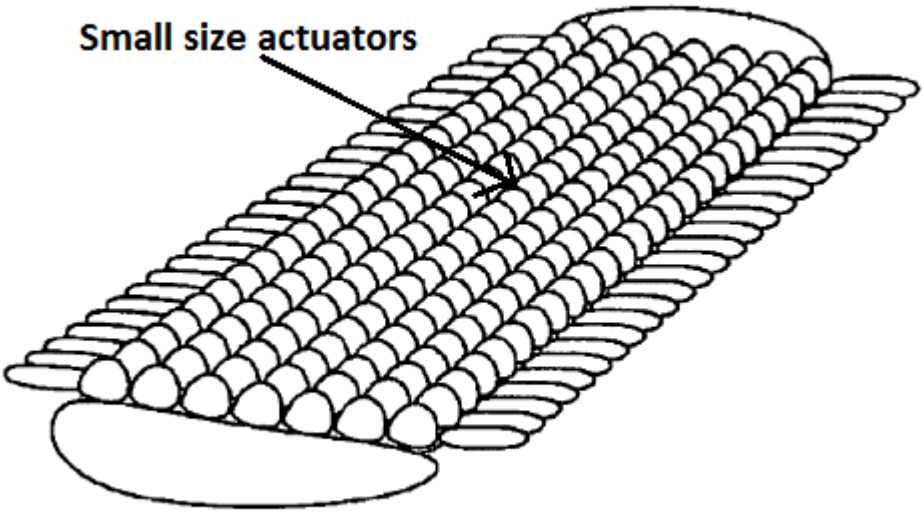


Figure 4: Idea/Process 3

Another mechanical device is shown in figure 4, which uses multitude of small sized actuators can successively transfer an object in contact with the outer surfaces thereof and can transfer a seriously ill patient from the movable bed of the mechanical device to the bed at the operation theatre. In this case, also the height of the two beds need to be equal which can be achieved with a proper mechanism which can adjust the height of the bed of the mechanical device.

CHAPTER 5

Evaluation of Ideas

5.1 EVALUATION OF IDEAS OR PROCESSES

All the ideas or processes that were found out, were described in the last section. Now it is time to decide which idea may be the best suitable solution for our problem subject to certain constraints or parameters. The parameters which can be considered are.

- Cost
- Time to develop
- Feasibility
- Usability

Table 2: Evaluation of ideas

Idea / Parameter	Idea 1	Idea 2	Idea 3
Cost (Rs.)	15000	25000	20000
Time to develop (days)	100	90	120
Feasibility (%)	80	95	70
Usability (%)	60	90	70

Lower better

higher better

The values in the table 2 are not exact. These are guessed considering existing engineering knowledge i.e. the approximate values. There are various techniques which can be adopted for determining the best idea, one of them is TOPSIS (Technique for Ordered Preference by Similarity to Ideal Solution). Out of the parameters listed above, cost and time to develop are "Lower the Better" parameters. And feasibility, usability are "Higher the Better" parameters.

Table 3: Decision matrix

Idea	Cost(Rs.)	time (days)	feasibility	usability
1	15000	100	80	60
2	25000	90	95	90
3	20000	120	70	70

Then normalized decision matrix is made with the elements

$$Rij = \frac{Xij}{\sqrt{\sum_1^n Xij\text{^}2}}$$

Table 4: Normalized decision matrix

Idea	cost	time	feasibility	usability
1	0.323498	0.4850713	0.489363	0.41577536
2	0.539164	0.4365641	0.5811186	0.62366304
3	0.431331	0.5820855	0.4281926	0.48507125

Then the weighted normalized matrix is to be constructed. The weights are given to different parameters as, .2 for cost, 0.2 for time, 0.25 for feasibility and 0.35 for usability.

Now in the weighted normalized matrix,

Vij = Rij * Wj

Where Wj is the weight of the parameter.

Table 5: Weighted normalized matrix

Idea	cost	time	feasibility	usability
1	0.0647	0.0970143	0.1223408	0.14552138
2	0.107833	0.0873128	0.1452796	0.21828206
3	0.086266	0.1164171	0.1070482	0.16977494

Table 6: Minimum and maximum values

MINIMUM	0.0647	0.0873128	0.1070482	0.14552138
MAXIMUM	0.129399	0.1164171	0.1452796	0.21828206

Ideal solution is the one with having minimum value for a parameter of "Lower the Better" and having maximum value for a parameter of "Higher the Better". 5

Table 7: Ideal and Non-ideal solutions

Non ideal	0.129399	0.1164171	0.1070482	0.14552138
Ideal	0.0647	0.0873128	0.1452796	0.21828206

Now the Euclidian distances of each idea from the ideal solution & the negative ideal solution is calculated using the formulae given.

$$Di^* = \sqrt{\sum_{j=1}^{m}(Vij - Vj*)}\ ^2 \quad \text{where I = 1, 2, 3… n}$$

$$Di- = \sqrt{\sum_{j=1}^{m}(Vij - Vj-)}\ ^2 \quad \text{where I = 1, 2, 3… n}$$

Table 8: Euclidian distances

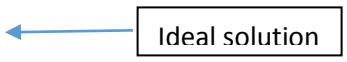
Idea	Di*	Di-
1	0.076905	0.0692559
2	0.043133	0.0898217
3	0.071601	0.0494843

Then the relative closeness of each alternative w.r.t. ideal and negative ideal solutions are calculated using the formulae given below,

$$RCi^* = \frac{Di*}{Di* + Di-} \quad , \quad RCi- = \frac{Di-}{Di* + Di-}$$

Table 9: Relative closeness

Idea	RCi*	RCi-
1	0.526168	0.4738323
2	0.324419	0.6755807
3	0.591328	0.4086719



The ideal solution is the one closest to the ideal solution as indicated in table 9 i.e. the idea with the RC* value or the highest RC- value. So, idea no. 2 is the ideal solution. Hence **idea 2** is selected for further consideration.

CHAPTER 6

Alternative devices from selected Idea

Evaluation of Final Product for development

Objective Tree

SWOT Analysis

Detail Functional Design Tree

6.1 MORPHOLOGICAL ANALYSIS TO GENERATE DEVICES FROM SELECTED IDEA

In this process, the selected idea is divided into different functions or components combining which the final product can be made. Different functions of the idea can be listed first. We have a basic idea and some modifications to that idea can be thought of. Let's first list down the functions first, then the alternatives for each function can be listed down. So the functions are listed below,

(i) Vibration of loading/unloading element (means of producing)

(ii) Means of transportation of the vehicle

(iii) Means of moving the device back and forth

(iv) Obstacle on other side for preventing sliding of the patient

(v) Height adjustment of the apparatus

(vi) Suspension

(viii) Body/Frame

(ix) Brake

Table 10: Alternatives for different functions

Function	Alternative 1	Alternative 2	Alternative 3	Alternative 4
(a) Vibration	Transducer	Drive amplifier		
(b) Means of transportation	Wheels	Spherical rollers		
(c) Means of moving back and forth	Rollers(manually)	mechatronics		
(d) Obstacle	Soft material	Overhead shield		
(e) Height adjustment	Cross type	Hydraulic	Pneumatic	Electric
(f) Suspension	Spring	Hydraulic	No suspension	
(g) Supply control	Position sensor	none		
(h) Brake	Internal expanding	Shoe brake	Drum brake	

Sandland S. [9] and Menna E. [8] in their respective patents had shown a transfer device which has been taken into consideration. The alternatives of each function have been listed down in table 10.

Combining all the alternatives of all the functions, the no. of devices possible are

2*2*2*2*4*3*2*3=1152

Out of all those possible devices the feasible and compatible ones are shortlisted below. Out of these one will be selected for further design consideration. Those are listed below

D1: a1-b1-c1-d1-e1-f1-g1-h1

D2: a2-b1-c1-d2-e3-f2-g1-h1

D3: a1-b2-c1-d1-e2-f2-g1-h2

D4: a1-b1-c1-d1-e4-f1-g1-h2

D5: a2-b1-c2-d2-e2-f1-g1-h1

D6: a1-b2-c2-d1-e1-f3-g2-h2

D7: a2-b1-c1-d2-e2-f2-g1-h2

D8: a1-b2-c1-d1-e3-f1-g1-h1

6.2 EVALUATION OF FINAL PRODUCT FOR DEVELOPMENT

For selecting the best device suitable for designing, certain parameters have been taken into consideration i.e.

- Cost
- Response time
- Safety
- Performance
- Life period

The marks for corresponding parameters has been be given (out of 10) to different feasible products in table 11 from the existing engineering knowledge. The marks given are entirely approximate and not exact. The one with the highest mark is going to be selected finally for further designing.

Table 11: Final product evaluation

Device / Factor	D1	D2	D3	D4	D5	D6	D7	D8
Cost	8	7	8	6	8	8	8	9
Response time	6	6	6	6	6	7	6	6
Safety	8	6	6	6	7	7	6	7
Performance	6	6	8	6	7	8	6	7
Life period	8	7	7	6	8	9	9	9
Total mark	36	32	35	30	36	39	35	38

The highest mark is secured by D6. Hence D6 would be designed further.

6.3 OBJECTIVE TREE

- It provides the checking and ensures that the final product addresses all the objectives or not.
- It is a graphical representation of the prime and subsidiary objectives of the final product one want to develop.
- It is going to affect the decision on choosing the mechanisms and components to be used for the final product.
- The objective tree depends on the product.

The objective tree shown in figure 5,

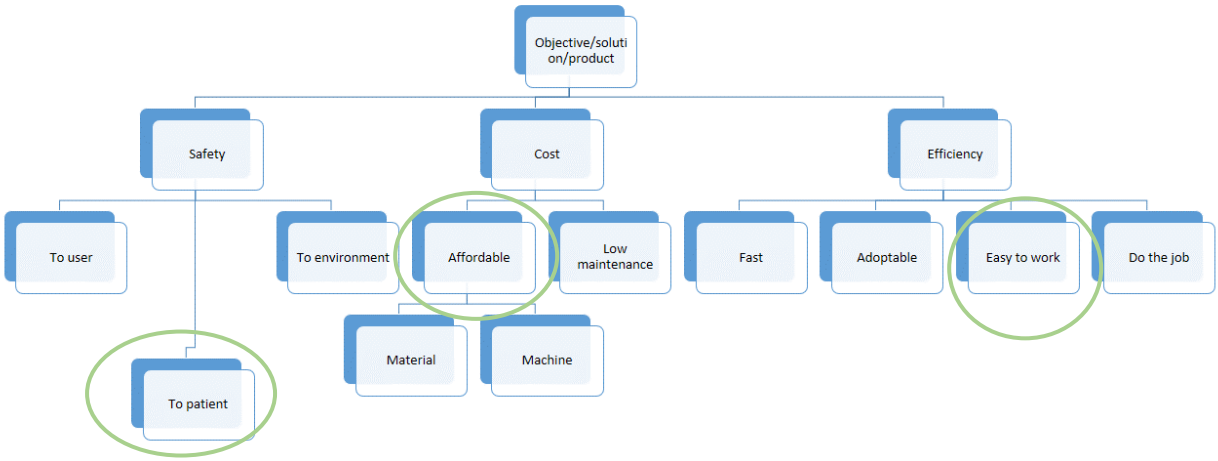


Figure 5: Objective Tree

Here the objective is "Handling and transferring the patient with utmost delicacy".

- In our case, safety is of utmost importance for the patient. So safety is given priority in this product development.
- Cost should not be very high. It should be affordable. However when it comes a situation where for choosing the material or designing a process, safety of the product will be given first preference.
- Efficiency of the product need not be very high. It can be easy to work. Efficiency of the system can be compromised to the safety of the patient.
- When this product is put in the objective tree for evaluation, the results are quite satisfactory keeping the proposed conditions in the last page. It has been highlighted with the green circles in the objective tree in the last page.

N.B.:

It has been repeatedly mentioned that “safety of the patient” cannot be compromised under any circumstances whether it comes to efficiency or cost or production time.

6.4 SWOT ANALYSIS

SWOT refers to **S**trength-**W**eakness-**O**pportunities-**T**hreats.

It will give an overall commercial opportunity of the developed product. It lists out the following attributes about the product if goes for production.

- Strength

  Characteristics of the business or project that give it an advantage over others.

- Weakness

  Characteristics that place the business or project at a disadvantage relative to others.

- Opportunities

  Elements that the business or project could exploit to its advantage.

- Threats

  Elements in the environment that cause trouble for the business or project.

Strengths and weaknesses are the attributes of the organization whereas opportunities and threats are the attributes of the environment.

The figure 6 demonstrates the SWOT analysis of this project considering some factors.

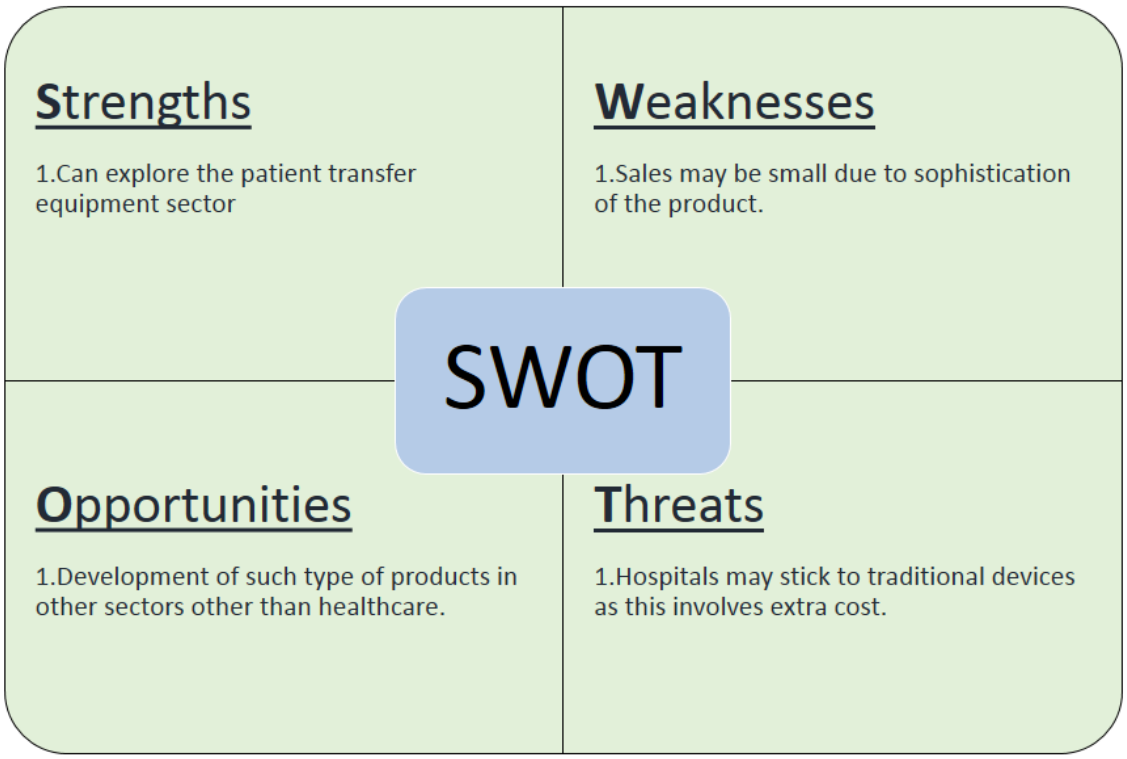


Figure 6: SWOT Analysis

6.5 DETAIL FUNCTIONAL DESIGN TREE

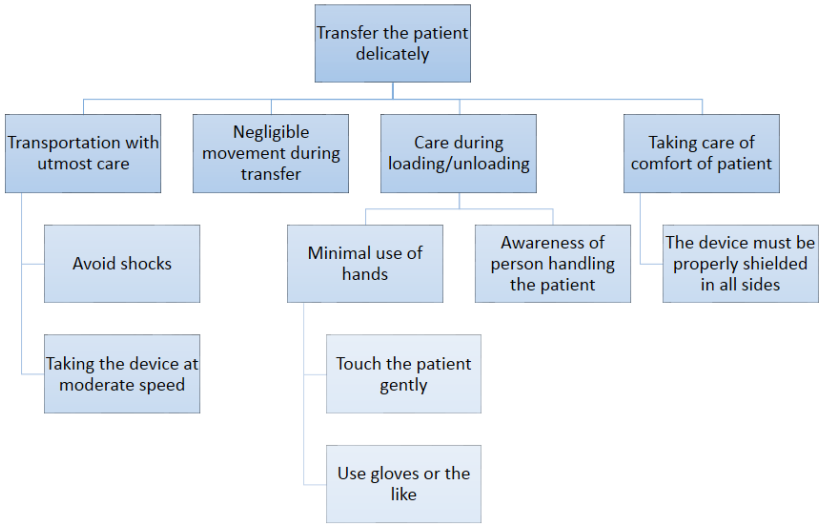


Figure 7: Deail Functional Design Tree

The detail functional design tree for this project has been constructed in figure 7.

CHAPTER 7

Drawing and detail specifications

7.1 FINAL DESIGN

The selected design i.e. D6 has the following functions with their respective means for achieving that.

- Vibration : Transducer
- Transportation : Wheels
- Means of moving in transverse direction : Rollers in slots
- Obstacle : Soft material on the other side
- Height adjustment : Cross type
- Suspension : (no suspension provided)
- Supply control : none
- Brake : Shoe brake

Basically the final design of the device is kind of a semi-automatic type. Because it involves control systems to control the loading/unloading action of the transfer elements and at the same time the person operating the device would have to keep hands a little on the patient while transferring ensuring proper transfer of the patient from the OT table to the bed of the device without any kind of hassles.

LOADING/UNLOADING ELEMENTS

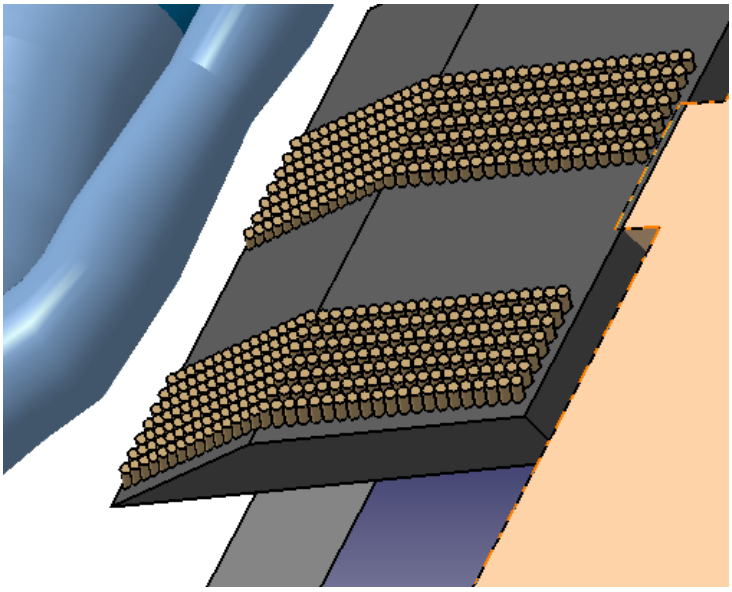


Figure 8: Loading/Unloading elements

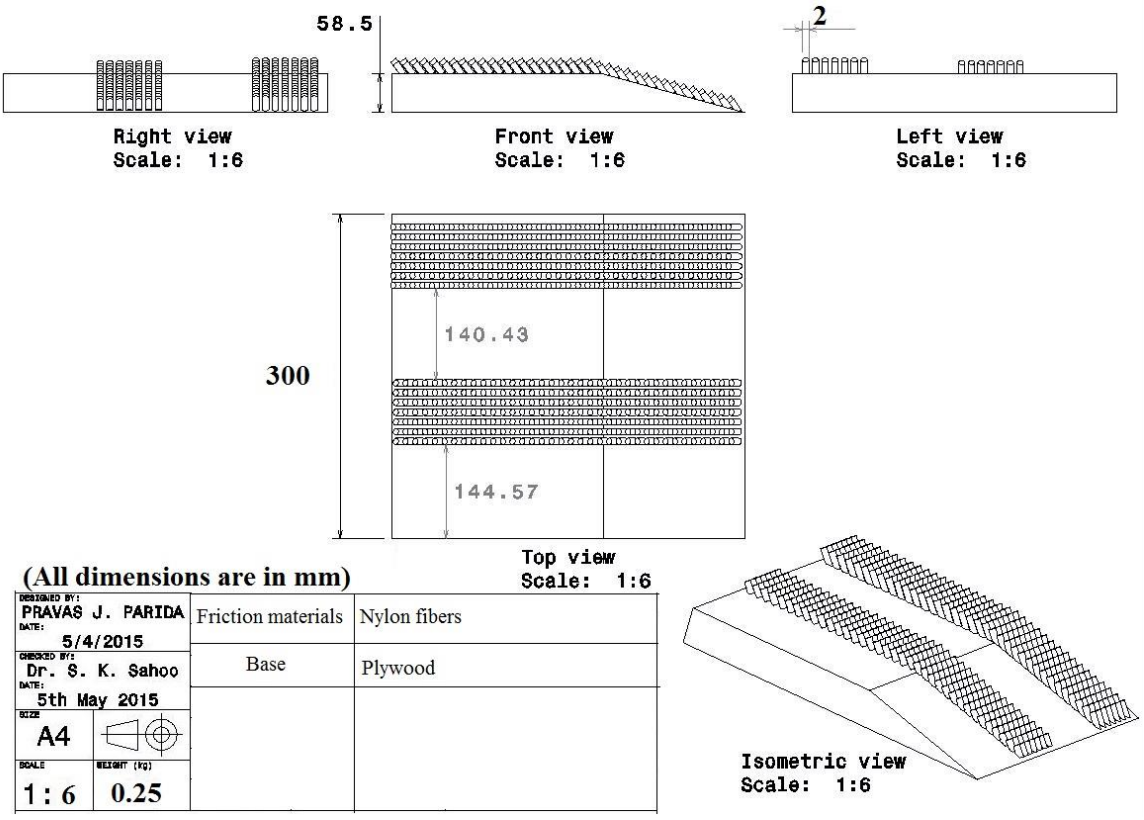


Figure 9: All views of loading/unloading elements

The figure 8 in the last page illustrates the loading/unloading element that has been used in our design. In figure 9, all the views i.e. front view top view, side view, isometric view etc. has been shown. In this design there are two of these elements. Suitable materials can be used for these elements to facilitate the operation being carried out in a very smooth and effective manner. Elastic fibers can be provided as being elastic body of the patient would not stick with the loading/unloading elements and upon suitable elastic deformation of the material, loading/unloading is fairly easy. Materials can be taken for example nylon fibers, acrylic fibers & carbon fibers. On the oblique as well as plane surface of the loading/unloading element fibers of two types in orientation is provided. The orientation in which the fibers has been shown in figure 8 are for loading the body. In this case the fibers are aligned in the right direction. So, as the board is moved towards the left, due to static friction, certain amount of force would act on the body and the body won't move. When some rightward movement would be given to the unit, the body would move a bit rightwards due to the direction in which the fibers are aligned. It's noted that the amplitude of vibration to be given is very small. All these happen while loading

the patient from the OT table to the transfer device. When the unloading would be the requirement then the current fibers would be switched off i.e. those would go inside the element and the other fibers in the element would come out of the element which would be aligned towards right. The unloading process would happen in the same principle but in opposite direction. The main base device would be traversed towards the OT table by proper control while the loading/unloading element would be vibrated by a small amplitude.

The direction of vibration of the loading unloading elements has been slightly modified to facilitate the require action to happen more easily. This has been illustrated in the figure below in a clear manner.

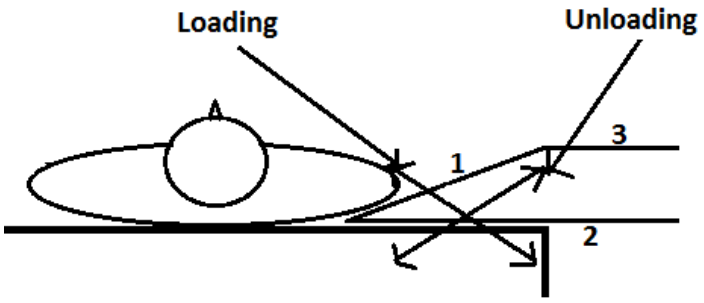


Figure 10: Directions of vibration

As shown in the figure 10, the direction in which the elements is vibrated for loading operation the body slide on to the bed of the transfer device due to the effect of this little direction change as well as due to the effect of fibers. The same thing happens during unloading but in opposite direction. The same material (elastic fiber) can be provided to all the three surfaces 1, 2 and 3 as shown in figure 10.

Vibration:

The electro mechanical conversion system, a driving circuit are used for producing vibration required for the loading/unloading elements. In this case transducer has been used.

Transportation:

For transporting the transfer device from one place to another, wheels are used as can be seen from the assembly diagram. No shock absorber or the like is attached to keep the cost of manufacturing moderate.

Moving in transverse direction:

For moving the transfer unit towards the OT table while vibrating the loading/unloading elements, rollers are used which travel in the slots made. This can be achieved manually. However automatic system can be provided which would incur more cost.

Obstacle:

To avoid the patient from falling down the bed of the transfer device, a soft material is attached on the other side of the transfer device so as to support the patient.

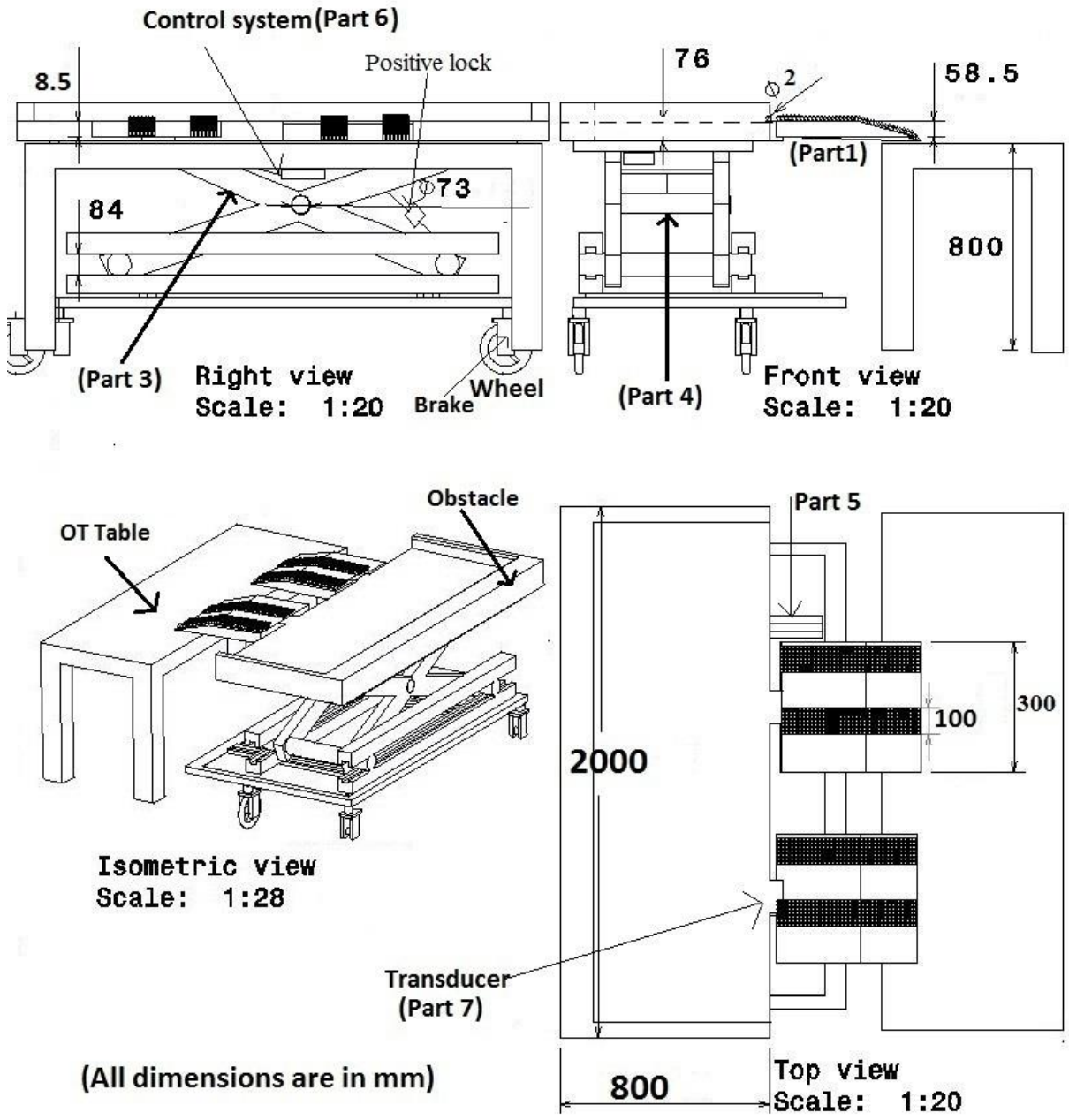
Height adjustment:

A cross type revolute joint has been used for adjusting the height of the transfer device. This is achieved manually by adjusting the height and giving a positive lock to lock the revolute joint for further operation. A positive lock is provided to lock the vertical position of the device while in operation.

Brake:

Shoe brake has been used over here stopping the transfer device when required. Handle for the brakes are placed in such a position that is accessible to the operator.

The front view, top view, side view and the isometric view of the final design has been shown in figure 11 with the listing of the parts.



DESIGNED BY: PRAVAS J. PARIDA DATE: 5/4/2015 CHECKED BY: Dr. S. K. Sahoo DATE: 5th May 2015 SIZE A4 SCALE 1:20 WEIGHT (Kg) 50	Part 1	Loading/Unloading Unit	Elastic fiber
	Part 2	Bed of device	Cushion
	Part 3	Height adjustment mechanism	Steel
	Part 4	Connecting rod	Steel
	Part 5	Slot for transverse traversal	-
	Part 6	Control system	-
	Part 7	Transducer for vibration	Mechatronics

Figure 11: All views of the device

An isometric view of the device is shown in the figure 12 which is the actual design which has been done using CATIA V5R20.

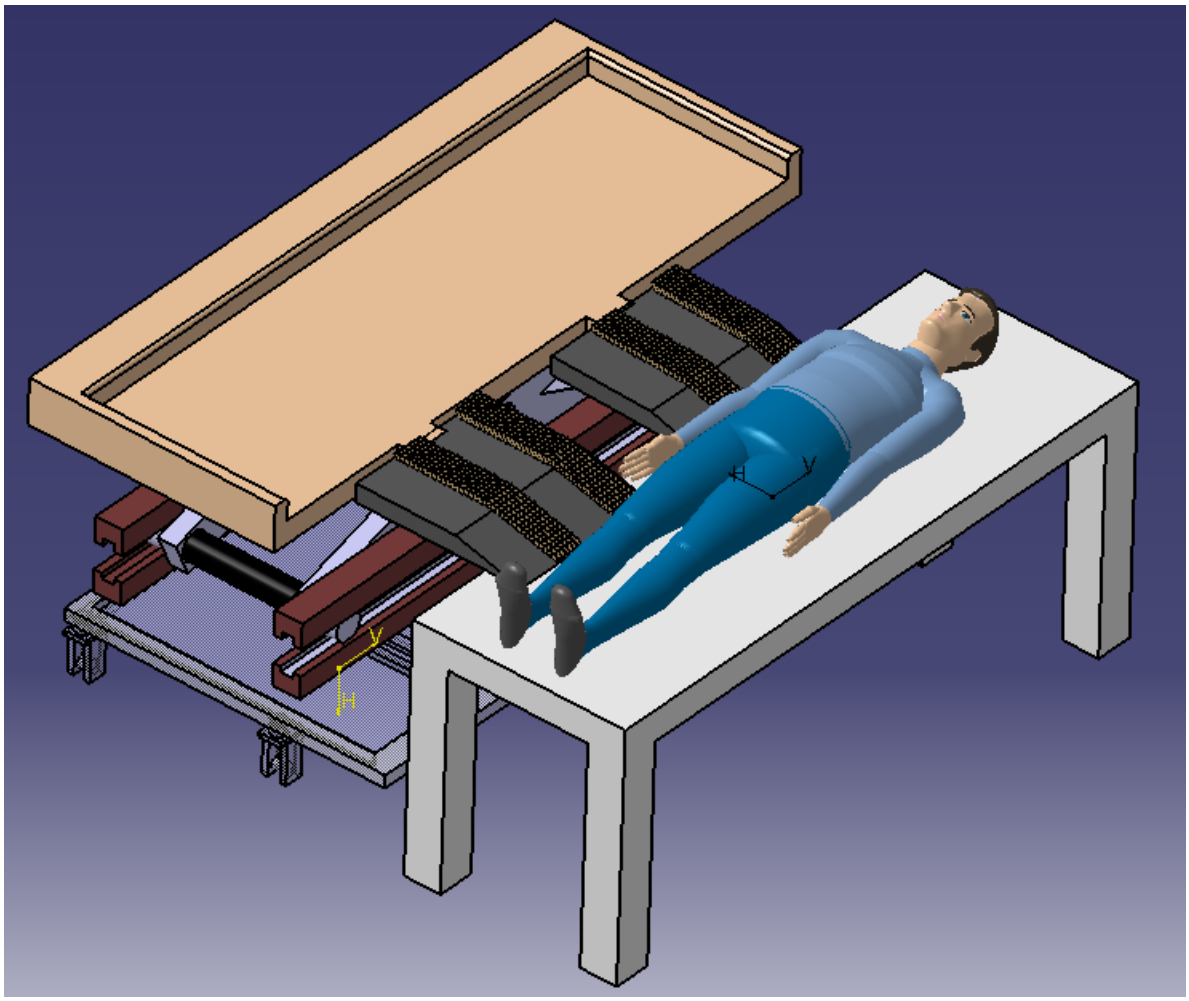


Figure 12: Isometric view of the device

CHAPTER 8

Result and conclusion

Patent writing

References

8.1 RESULT AND CONCLUSION

8.1.1 RESULT

Out of the various alternative ideas that was proposed for our problem, the idea with the separate loading/unloading elements has been most suitable. The device designed is not that costly as well as it is easy to operate the maintenance cost is also less.

8.1.2 CONCLUSION

The device designed will be suitable for transferring seriously ill patients from one table to another without touching them much. This would reduce the chances of the patient being hurt due to any possible disturbances or the like. A complete exhaustive search has been made across various patents, journals and international publications for finding suitable alternative designs for the stated problem. Then suitable evaluations have been done to find the best suitable idea or process. Then, further evaluations have been carried out to reach to the final design in terms of its functions and components. In the end a final design has been provided.

8.2 PATENT WRITING

TITLE OF THE INVENTION

Design of mechanical device to transfer a seriously ill person to the operation theater.

APPLICANT

(a) NAME: National Institute of Technology Rourkela

(b) NATIONALITY: Indian

(c) ADDRESS: NIT Rourkela, Rourkela, Odisha, India

COMPLETE SPECIFICATION

Design of mechanical device to transfer a seriously ill person to the operation theater.

Technical field of Invention:

STATEMENT OF INVENTION:

The present invention discloses/relates to the conceptual design of a mechanical device that would be used for transferring a seriously ill patient from one table to another. The device designed is semi-automatic in nature and full automatic feature can also be incorporated also.

BACKGROUND OF INVENTION:

The problem in transferring seriously ill/injured persons in operation theatres has been escalating in the recent years. The patient is highly vulnerable to any slight shock or disturbances, which makes it important for the transfer device to be really good at giving great comfort to the patient. The conventional ways of transferring the patients are using the normal stretcher which may be of different height from the OT table itself, and then manually transferring the patient from one table to another using hands and lifting the patient along with the bed sheet or bed. However this method cannot be suitable for heavily injured patients. And therefore a more technically competent device is designed which would transfer the patient with minimal use of hands.

OBJECTIVE OF THE INVENTION:

To design a transfer device that will be used to transfer a seriously ill/injured patient from the patient's cabin (within the hospital)/ambulance (emergency) to the operation theatre safely in a delicate manner. While loading/unloading the patient extreme care would be taken so as to avoid any kind of disturbances as the patient is extremely vulnerable to these.

SUMMARY OF INVENTION:

The important aspect of the present invention is that it include a loading/unloading elements which uses friction to transfer the patient from one bed to another. The height of the transfer device can be adjusted to make it same as that of the table in the operation theatre to make the process of transfer happen in an efficient manner. The entire device is moved towards the OT table while vibrating the loading/unloading elements to facilitate the action.

DRAWINGS

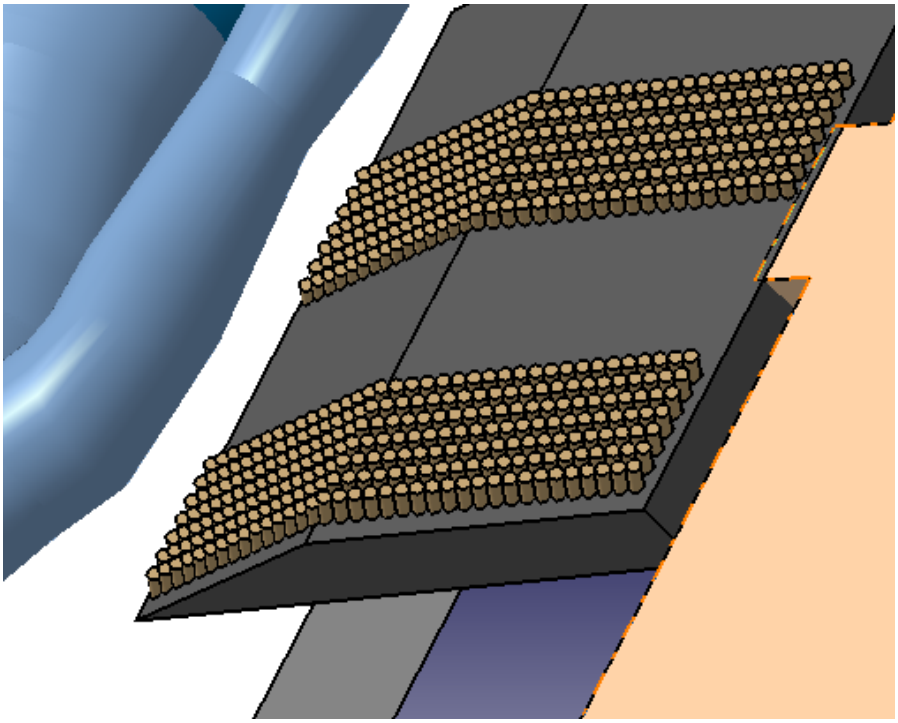


Figure 13: Loading/unloading elements

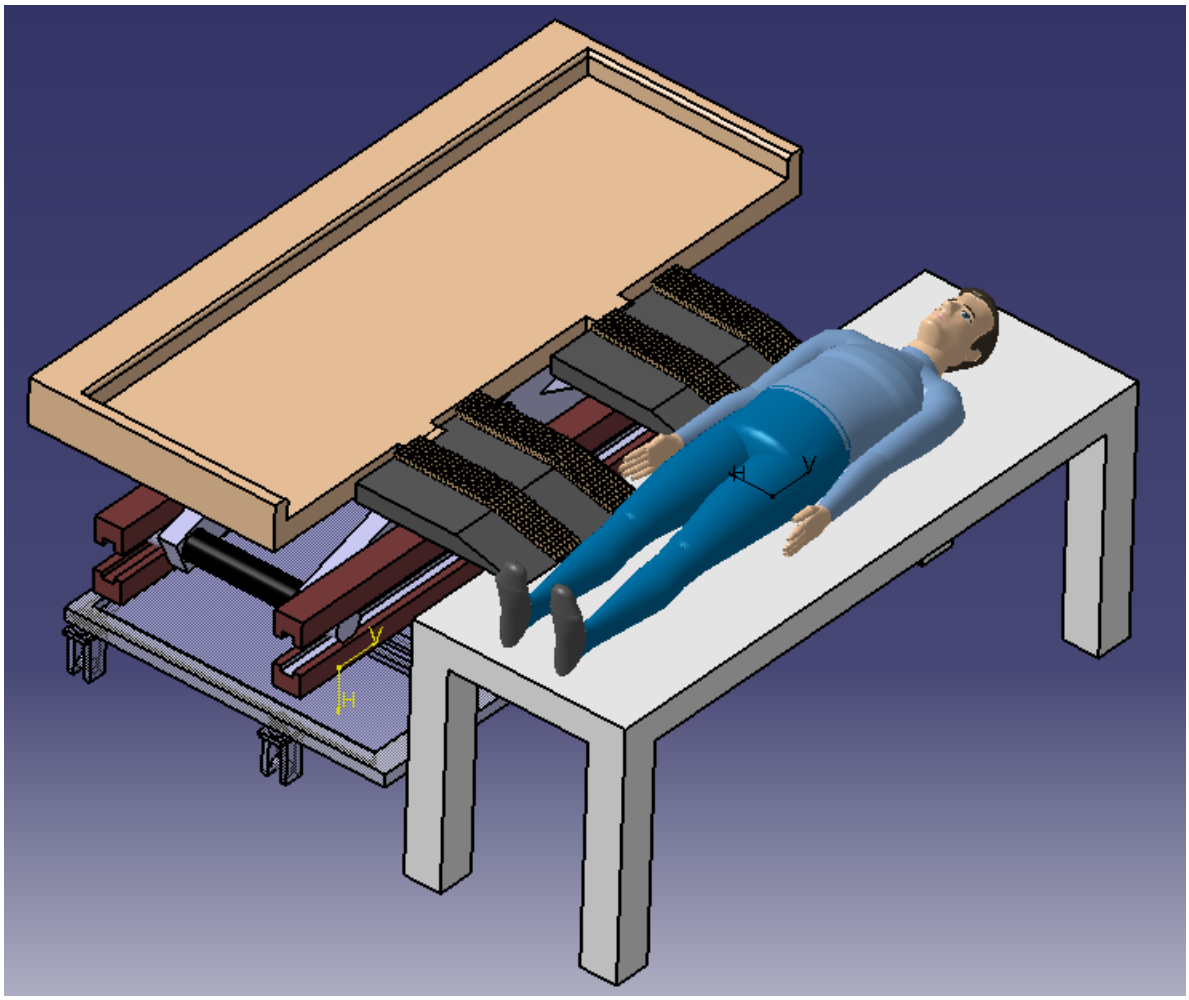


Figure 14: Isometric view of the device

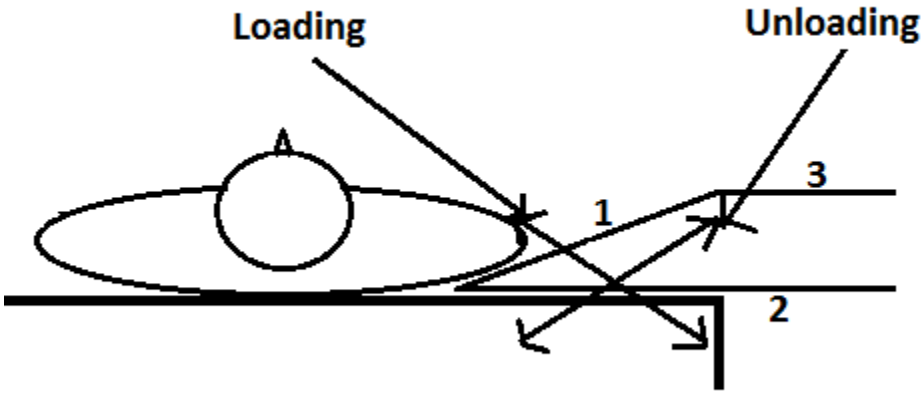
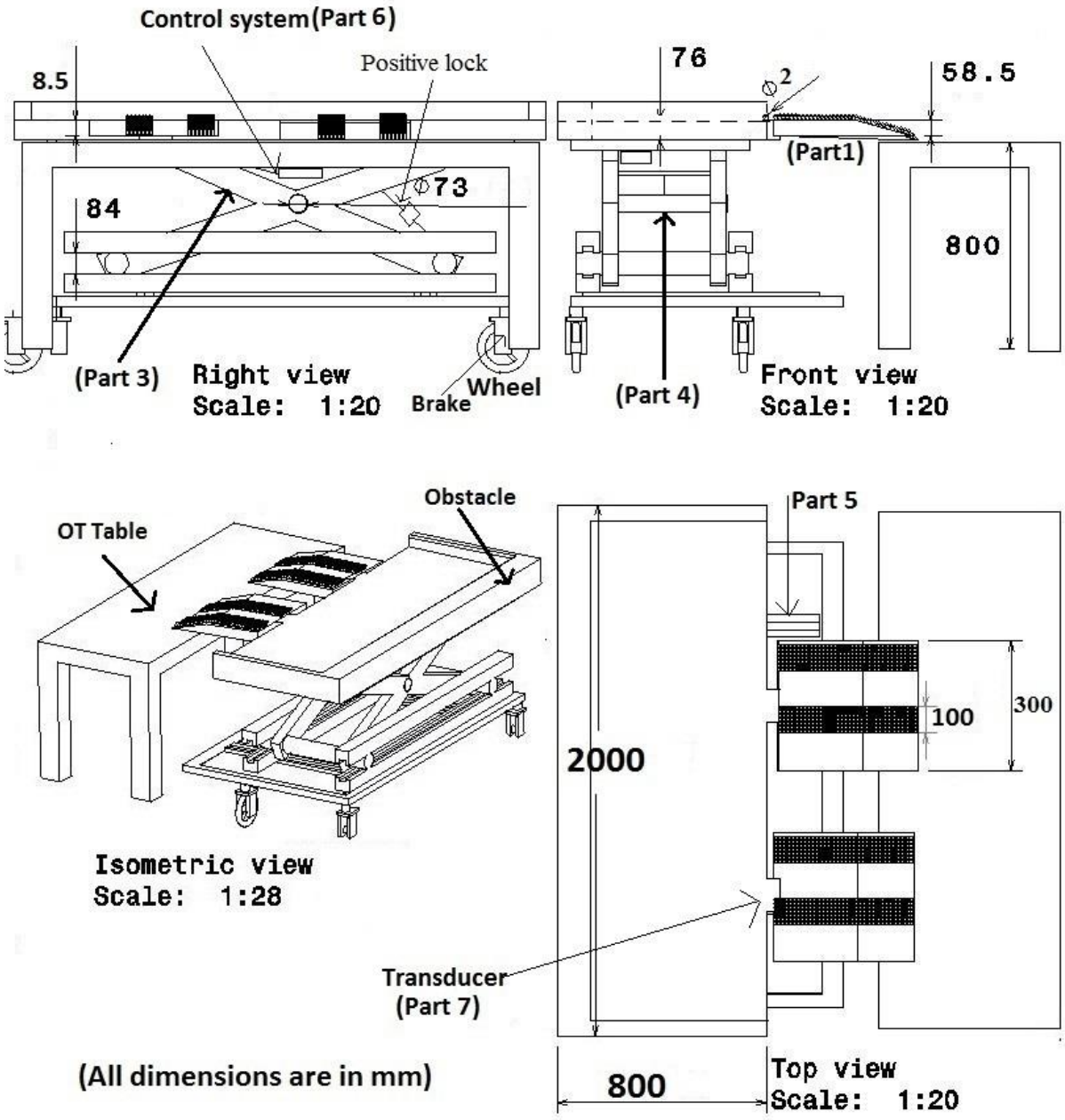


Figure 15: Directions of vibration



DESIGNED BY: PRAVAS J. PARIDA DATE: 5/4/2015 CHECKED BY: Dr. S. K. Sahoo DATE: 5th May 2015 SIZE: A4 SCALE: 1:20 WEIGHT (kg): 50	Part 1	Loading/Unloading Unit	Elastic fiber
	Part 2	Bed of device	Cushion
	Part 3	Height adjustment mechanism	Steel
	Part 4	Connecting rod	Steel
	Part 5	Slot for transverse traversal	-
	Part 6	Control system	-
	Part 7	Transducer for vibration	Mechatronics

Figure 16: All views of the device

DETAILED DESCRIPTION

Figure 13 represents the loading/unloading element. In this design there are two of these elements. Suitable materials can be used for these elements to facilitate the operation being carried out in a very smooth and effective manner. Elastic fibers can be provided as being elastic body of the patient would not stick with the loading/unloading elements and upon suitable elastic deformation of the material, loading/unloading is fairly easy. Materials can be taken for example nylon fibers, acrylic fibers & carbon fibers. On the oblique as well as plane surface of the loading/unloading element fibers of two types in orientation is provided. The orientation in which the fibers has been shown in figure 13 are for loading the body. In this case the fibers are aligned in the right direction. So, as the board is moved towards the left, due to static friction, certain amount of force would act on the body and the body won't move. When some rightward movement would be given to the element, the body would move a bit rightwards due to the direction in which the fibers are aligned. It's noted that the amplitude of vibration to be given is very small. All these happen while loading the patient from the OT table to the transfer device. When the unloading would be the requirement then the current fibers would be switched off i.e. those would go inside the element and the other fibers in the element would come out of the element which would be aligned towards right. The unloading process would happen in the same principle but in opposite direction. The main base device would be traversed towards the OT table by proper control while the loading/unloading element would be vibrated by a small amplitude.

In figure 14 an isometric view of the final device along with the table in the operation theater has been given. This design has been made using solid modeling software CATIA.

Figure 15 depicts the two different directions in which the loading/unloading elements are vibrated while loading and while unloading the patient on to/ off the transfer device.

Then the figure 16 contains all the views i.e. front view, right hand side view, top view and the isometric view etc. The first angle projection has been used in this drafting.

Vibration:

The electro mechanical conversion system, a driving circuit are used for producing vibration required for the loading/unloading elements. In this case transducer has been used.

Transportation:

For transporting the transfer device from one place to other wheels are used as can be seen from the assembly diagram. No shock absorber or the like is attached to keep the cost of manufacturing moderate.

Moving in transverse direction:

For moving the transfer unit towards the OT table while vibrating the loading/unloading elements, rollers are used which travel in the slots made. This can be achieved manually. However automatic system can be provided which can incur more cost.

Obstacle:

To avoid the patient from falling down the bed of the transfer device, a soft material is attached on the other side of the transfer device so as to support the patient.

Height adjustment:

A cross type revolute joint has been used for adjusting the height of the transfer device. This is achieved manually by adjusting the height and giving a positive lock to lock the revolute joint for further operation.

Brake:

Shoe brake has been used over here stopping the transfer device when required. Handle for the brakes are placed in such a position that is accessible to the operator.

CITATION:

Table 12: Citations for patent

Cited Patent	Filing date	Publication date	Applicant	Title
US2007/0295339 A1	Jun_ 27, 2007	Dec. 27, 2007		Loading/Unloading unit and a transfer apparatus
US 6,526,611 B2	Jan. 4, 2002	Mar. 4, 2003	Ferno-Washington, Inc.	Ambulance stretcher with improved height adjustment feature
US 7,694,368 B2	Jul. 18, 2007	Apr. 13, 2010	Ferno-Washington, Inc.	Positive lock for height adjustable ambulance cot
7,637,550	July 22, 2008	Nov 12, 2009	Stem S.R.L.	*Stretcher* and a patient transport system

CLAIMS

We claim:

1. A method for transferring the patient from one table to another with minimal use of hands.
2. An obstacle on the other side of the transfer device to prevent falling down of the patient due to the little forces supplied by the vibrator.
3. A method for adjusting the height of the transfer device while transferring the patient from one table to another.
4. A method for traversing the device in the transverse direction i.e. towards the OT table.

Pravas Janmejay Parida, Dr. S. K. Sahoo
of National Institute of Technology
Rourkela 769008
Dated this_5th may 2015

TITLE

Design of mechanical device to transfer a seriously ill person to the operation theater

Abstract

The problem in transferring a patient from OT table to the stretcher or the transportation system is very common in almost all the hospitals or Operation theatres. Generally, the patient is transferred from the table in the operation theatre to the transporting stretcher or the like manually by hand or lifting the entire bed sheet or bed along with the patient. As we are dealing with seriously ill or injured patients, any kind of disturbances even to a small extent are likely to hurt the patient. So a device is designed that helps in properly loading/unloading the patient on to/off the table in the operation theatre with minimal use of hands of people. The device to be designed may be semi-manual or semi-automatic or fully automatic keeping the cost that would incur in manufacturing moderate. As per procedure, initially the problem is properly defined and exhaustive search was carried out for different types of ideas or processes for the problem. After that, systematic evaluation of ideas was carried out to select the best idea or process for the product to be designed. Basically, this design is a modification of an existing design with some added features for the stated problem.

8.3 REFERENCES

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